$$\text{(1)} \qquad \frac{dT}{dt} = K\left[M(t) - T(t)\right] + H(t) + U(t) \,,$$

Solving for $T(t)$ gives

$$\text{(4)} \qquad T(t) = e^{-Kt}\int e^{Kt}Q(t)dt + Ce^{-Kt}$$

$$= e^{-Kt}\left\{\int e^{Kt}\left[KM(t) + H(t) + U(t)\right]dt + C\right\}.$$

Example 1 Suppose at the end of the day (at time t_0), when people leave the building, the outside temperature stays constant at M_0, the additional heating rate H inside the building is zero, and the furnace/air conditioner rate U is zero. Determine $T(t)$, given the initial condition $T(t_0) = T_0$.

On a mild Saturday morning while people are working inside, the furnace keeps the temperature inside the building at 21°C. At noon the furnace is turned off, and the people go home. The temperature outside is a constant 12°C for the rest of the afternoon. If the time constant for the building is 3 hr, when will the temperature inside the building reach 16°C? If some windows are left open and the time constant drops to 2 hr, when will the temperature inside reach 16°C?

1. **Kirchhoff's current law** The algebraic sum of the currents flowing into any junction point must be zero.
2. **Kirchhoff's voltage law** The algebraic sum of the instantaneous changes in potential (voltage drops) around any closed loop must be zero.

(a) According to Ohm's law, the voltage drop E_R across a resistor is proportional to the current I passing through the resistor:

$$E_R = RI .$$

The proportionality constant R is called the **resistance.**

(b) It can be shown using Faraday's law and Lenz's law that the voltage drop E_L across an inductor is proportional to the instantaneous rate of change of the current I:

$$E_L = L\frac{dI}{dt} .$$

The proportionality constant L is called the **inductance.**

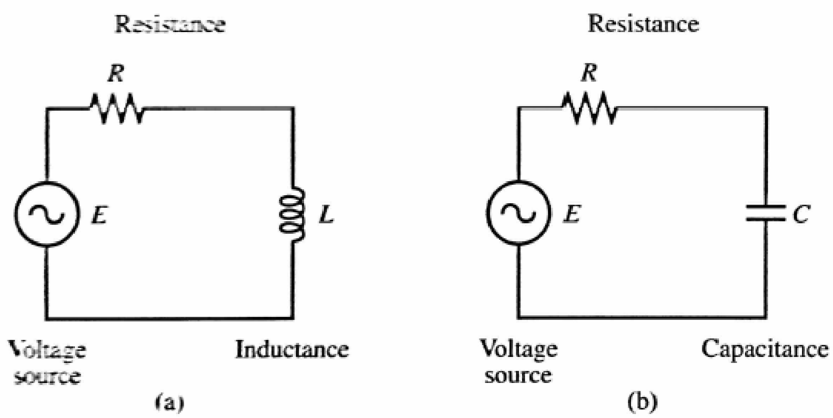


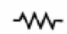
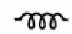
Figure 3.13 (a) *RL* circuit and (b) *RC* circuit

(c) The voltage drop E_C across a capacitor is proportional to the electrical charge q on the capacitor:

$$E_C = \frac{1}{C} q \, .$$

The constant C is called the **capacitance.**

TABLE 3.3 **Common Units and Symbols Used With Electrical Circuits**

Quantity	**Letter Representation**	**Units**	**Symbol Representation**
Voltage source	E	volt (V)	 Generator  Battery
Resistance	R	ohm (Ω)	
Inductance	L	henry (H)	
Capacitance	C	farad (F)	
Charge	q	coulomb (C)	
Current	I	ampere (A)	

Example 1 An RL circuit with a 1-Ω resistor and a 0.01-H inductor is driven by a voltage $E(t) = \sin 100t$ V. If the initial inductor current is zero, determine the subsequent resistor and inductor voltages and the current.